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A REVIEW OF CURRENT RESEARCH AND ACTIVITIES INVOLVING CHARACTERIZATION, ABATEMENT AND DISPOSAL OF LEAD-CONTAINING PAINT FILMS

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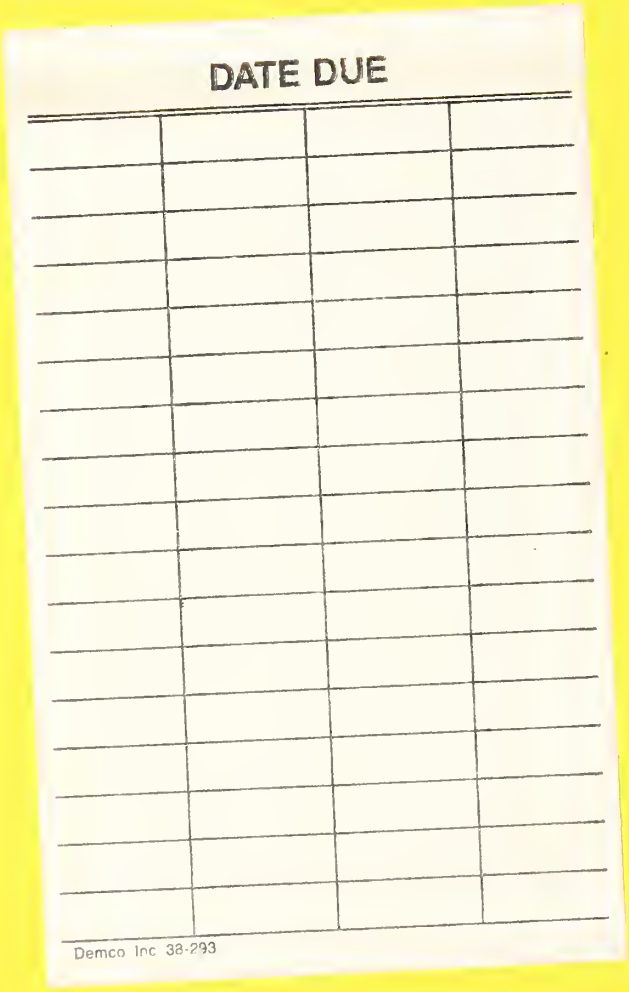

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CONTENTS

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Recent regulations for abating lead-based paint in housing and other environmental regulations have led to additional research and activities to provide information on procedures for abating and maintaining lead-containing paint films in a safe and cost-effective manner. Relevant Federal regulations, current research projects and other activities addressing these issues are reviewed.

Keywords: abatement; coatings; containment; disposal; films; lead; measurement; paint; removal.

1. INTRODUCTION

Lead-containing pigments have been used in paints to provide hiding, color, and corrosion control. At the present time their use is no longer permitted in residential paints [1] and their use in industrial paints is declining [2]. The U.S. Environmental Protection Agency (EPA) estimates that a total of 3 to 4 million tons of lead have been used in paint in the United States [3]. Hence, many existing paint films contain lead.

Federal and local regulations have been issued that affect lead-based paint films and paint. For example, abatement of lead-based paint films is required in U.S. Department of Housing and Urban Development (HUD) assisted housing. Regulations of the U.S. Department of Labor's Occupational Safety and Heath Administration (OSHA) and environmental regulations may affect the removal, handling, storage, and disposal of lead-containing paint debris. Consequently, there is a need for procedures for abating lead-containing painted surfaces.

Many studies have investigated procedures for measuring lead concentration in paint and abating lead-containing painted surfaces. Both types of procedures recently have been reviewed [2-4]. Because of changes in laws and regulations, additional research and other activities associated with maintenance and abatement of paint films containing lead on both residential and industrial structures are being conducted. For example, the U.S. Department of Housing and Urban Development and the Environmental Protection Agency are leading a large effort to improve abatement of lead-based paint in housing and the Steel Structures Painting Council is developing standards for removal and containment of lead-containing paint from industrial structures. Thus, there is a need for the Department of Defense to keep abreast of these efforts and to include their results in guidance and policy as it deems appropriate. This study was carried out at the request of the Tri-Service Committee on Facilities Coatings to 1) review laws and regulations pertinent to lead-containing paint, 2) describe current research activities, and 3) provide recommendations to the Committee for actions concerning lead-containing paint necessitated by changes in regulations. In the present report, the relevant laws and

regulations are outlined and current studies involving lead-containing paint films are briefly described. The paint studies are grouped as to their primary focus, residential or industrial.

2. LAWS AND REGULATIONS

Federal laws and regulations place limits on lead concentration in paints for residential use and in existing paint films in housing. State and local laws and regulations may be more restrictive than the Federal ones. Other regulations are applicable when lead-containing paint films are removed. These include waste, water and air environmental regulations and worker protection regulations. This section provides an overview of key Federal laws and regulations affecting lead in paint and paint films.

2.1 Paint

For liquid residential paint, a 1977 Consumer Product Safety Commission regulation fixed the maximum allowable level of lead in residential paints at 0.06 percent by mass of the nonvolatile paint solids [1] under the Consumer Product Safety Act. Previously, a March 1972 Food and Drug Administration regulation, under the Federal Hazardous Substances Act, had placed the limit at 0.5 percent by mass of nonvolatiles with a provision for decreasing the limit to 0.06 percent by mass of nonvolatiles in Dec. 1973 [5]. The lead content of paints produced for industrial use in the United States is not federally regulated.

2.2 Paint Films

For lead in paint films of residential dwelling units, HUD issued its most recent regulation in 1988. This regulation was in response to amendments to the Lead-Based Paint Poisoning and Prevention Act (LPPPA) by Section 566 of the Housing and Community Development Act of 1987 [6]. The regulation defines lead-based paint as that having a lead concentration of at least 1 mg/cm^2 and requires abatement of all painted surfaces in HUD assisted housing having lead-based paint. The Stewart B. McKinney Homeless Assistance Amendments Act of 1988 [7] amended the LPPPA and authorized Public Housing Authorities to use, as an abatement level, 0.06 percent lead by mass of nonvolatiles in existing paint films. In addition, several states or localities have more restrictive or inclusive regulations (e.g., lead content of paint films in private housing) regarding abatement of lead-containing paint than the Federal regulation.

2.3 Waste Regulations

Wastes generated by coating maintenance of lead-containing paint films from both residential and industrial structures may be hazardous under the Resource Conservation and Recovery Act (RCRA) because of their lead content. Hazardous wastes require special handling (from the time they are generated), storage, treatment and disposal. Wastes can be hazardous because of ignitability, corrosivity, reactivity or toxicity. EPA defines toxic waste based on the concentration of certain inorganic and organic chemicals leached from the waste using the EPA extraction procedure, Method 1310 (often called the EP tox test) [8]. For lead, waste is hazardous when the leachate contains at least 5 parts per million (ppm). For industrial structures, waste is usually composed of abrasive blasting debris or paint chips, rust and other debris created by hand or power tool removal. Often, the waste is hazardous.

Concerns for the accuracy and precision of Test Method 1310 have been reported [9]. Hence, EPA is in the process of promulgating a revised test method, Method 1311, for classifying leaching characteristics of waste [10], expected to become effective in the fall of 1990. In addition to being a more precise and accurate method, the revised method is reported to be easier and less expensive to perform and applicable to a greater number of types of wastes than Method 1310 [9]. However, more lead is usually leached from abrasive blast debris using Method 1311 than using Method 1310. Thus, the proposed change in the test method is expected to increase the amount of abrasive blast debris that will be classified as hazardous [9].

Another proposed change in the hazardous waste regulations will change the manner in which hazardous waste is handled [11]. For waste that is hazardous because of its lead content based on a leachate test, it is proposed that waste containing in excess of 2.5 percent lead (i.e., total lead concentration in the waste) be processed to recover the lead and waste containing less than 2.5 percent lead be treated to reduce the solubility of the lead compounds. The proposed standard for allowable lead in the leachate of treated lead-containing waste is 0.5 ppm.

In contrast to industrial paint debris that is usually made up of reasonably uniform small particles, waste from abatement of lead-based paint in housing is often made up of large pieces of wood or steel coated with paint. Because of the difficultly of conducting the EP toxicity test on this type of debris, EPA is preparing a report to provide additional guidance on classification of wastes from residential abatement projects. This report is scheduled for completion in August 1990.

2.4 Water Regulations

The improper handling or disposal of lead-containing paint debris could adversely affect water quality. Although EPA has developed criteria for lead discharge into streams (as well as zinc and chromium -- also of interest to the coatings industry), they are non-regulatory. Thus, state regulations have been written that limit discharge of lead into streams [12]. Some states have additional ground and drinking water-source standards for lead. These regulations may lead to special requirements for containment of lead-containing debris created in a paint removal process. For example, special containment requirements are usually a part of a bridge maintenance painting contract.

2.5 Air Regulations

The Clean Air Act and the National Ambient Air Quality Standards established a limit for lead in air that provides a margin of safety for all citizens from exposure to airborne lead. The act limits airborne lead concentration to 1.5 $\mu g/m^3$ of air, where concentration is defined as the maximum arithmetic mean concentration averaged over a calendar quarter [13,14]. Since many jobs involving paint removal do not last three months, this regulation may not be restrictive. However, for industrial workers in lead-related industries, OSHA has set, by regulation, a permissible exposure limit (PEL) of 50 $\mu g/m^3$, averaged over an 8 hour day and an action level of 30 $\mu g/m^3$ averaged over an 8 hour day [15]. These limits also are used for workers removing lead-containing paint [16]. OSHA has found that the PEL level is usually attainable using engineering controls and good work practices [17]. However, additional personal protection has been required to met these limits for some workers removing lead-containing paint by abrasive blasting [16, 18]. In one study, lead concentrations near abrasive blasting sites ranged from 80 to 800 $\mu g/m^3$ [16], while in another study, concentrations ranged from 1000 to 10,000 $\mu g/m^3$ [18].

States and localities may have more restrictive air regulations than Federal regulations. For example, Allegheny County, PA, adopted more restrictive regulations for abrasive blasting January 1, 1987 [19]. In this case, permits must be obtained from the County for abrasive blasting for projects in which areas greater than 93 m^2 (1000 ft^2) are to be blasted. The lead concentration in the air cannot exceed 10 $\mu g/m^3$ for an 8 hour day or 25 $\mu g/m^3$ at any instant, and the total suspended particulate level can not exceed 260 $\mu g/m^3$ for an 8 hour day, with the County determining the placement of the air monitors.

3. CURRENT ACTIVITIES REGARDING LEAD IN RESIDENTIAL APPLICATIONS

As a result of the 1987 amendments to the Lead-Based Paint Poisoning Prevention Act, and the McKinney Act of 1988, HUD, in coordination with the EPA and other Federal agencies, developed a comprehensive program to address abatement issues in housing and to prepare a compressive and workable plan for abatement

procedures, 2) determining the extent of the problem in both public and private housing, 3) testing of lead in paint films, 4) evaluating abatement procedures, 5) characterizing requirements for worker safety, 6) investigating cleanup procedures following abatement, 6) disposing of abatement debris, 7) determining the availability of workers to carry out required procedures and 8) training. Each of these issues is briefly discussed below.

3.1 Current Knowledge

To organize current information and make it readily available to the public, HUD supported a project with the National Institute of Building Sciences (NIBS) to develop a manual for testing and abatement of painted surfaces in compliance with the 1988 HUD regulation [20]. This manual was developed by a committee of experts (including those in health, science, public housing administration, abatement procedures, and environmental protection) using the NIBS consensus process. The document, which was completed in February 1989, was modified by HUD to narrow its scope to Public and Indian Housing and was submitted to the Office of Management and Budget in late 1989. Recent legislation requires that it be released no later than April 1, 1990.

3.2 Survey of the Extent of Lead-Based Paint in Nations Housing

A HUD sponsored survey is underway to determine the extent of lead in paint, dust, and, to a limited extent, soil in the Nation's housing. Both private and public housing are included in this survey. Factors included in the survey are age, concentration of lead, region of the country and housing type, i.e., single family or multifamily. A report on the survey is scheduled for completion in 1990.

3.3 Testing of Lead in Paint Films

The National Institute of Standards and Technology (NIST) conducted a study of test procedures for lead in paint films [21]. Both field and laboratory test procedures were included in the study. Two field tests, portable x-ray fluorescence (XRF) and spot tests, were studied. For field tests carried out using lead-specific XRF devices, it was concluded that, for concentrations near 1 mg/cm^2 (the HUD regulatory limit), the best estimate of precision of measurements made over wood, plaster and drywall is 0.6 mg/cm^2. The estimated systematic error of the procedure is 0.2 mg/cm^2. Based upon preliminary measurements, a spectrum analyzer portable XRF device showed promise for in-situ measurements. Spot tests, based upon sodium sulfide, failed to detect lead in paint films having a lead concentration of at least 1 mg/cm^2 about 10 percent of the time when carried out by an experienced laboratory technician. A standard laboratory method, ASTM D 3335, Test Method for Low Concentrations of Lead, Cadmium and Cobalt in Paint by Atomic Absorption Spectroscopy [22], describes a procedure having an interlaboratory coefficient of variation of 9 percent. This method accurately determined the amount of lead in the NIST standard reference lead-containing paint film material.

In related studies on the effectiveness of sodium sulfide spot tests, two reports [23,24], completed after the NIST literature reviews, found large false negative and false positive rates for in-situ testing of lead-in-paint, but one [24] found very small false negative and false positive rates using a modified procedure. The modified procedure involved soaking a paint chip overnight in 2.5 percent sodium hydroxide solution and then adding a drop of 8 percent sodium sulfide solution to the sodium hydroxide solution. A black coloring on the surface of the solution was used as a positive test for lead.

The use of laboratory testing to determine the concentration of lead in paint has led EPA to initiate activities to develop a laboratory accreditation program for testing of lead in paint films. Since dust and soil lead may also be included in paint abatement jobs, testing for lead in dust and soil will also be a part of the accreditation program. The laboratory accreditation procedure developed for asbestos testing [25] is being considered as a model for a paint accreditation program.

3.4 Abatement Procedures

HUD's abatement demonstration project covers many of the remaining issues. Abatements are being carried out in several hundred housing units in five urban areas. Both private and public housing are included in the study. The private-sector portion of the project is scheduled for completion in late 1990. Briefly, the steps of the project include: 1) measuring lead concentration in paint films to find units having lead-based paint, 2) abating the surfaces, 3) monitoring lead-dust generated and lead-dust remaining after cleanup as a function of abatement method and lead concentration, 4) assessing worker risks, 5) monitoring types and amounts of wastes generated as a function of abatement method, and 6) investigating procedures for reducing the amount of hazardous wastes generated. The abatement procedures are being carried out by private contractors. Hence, the number of contractors bidding on the jobs may provide an indication of the availability of qualified workers.

3.5 Training

HUD is also working to establish training programs for people involved in lead-based paint abatement, including public housing administrators, engineers, contractors, testers, and workers.

3.6 Safety

In addition to the HUD program, EPA is conducting experimental studies to support modeling of lead accumulation in humans. As a part of this effort, surveys are being conducted to determine lead levels in soil, dust, and blood in three major urban areas. A draft of this study is scheduled for completion in 1991. These data, together with other data on lead in water and food, are expected to aid in the understanding of the link between lead concentrations in paint, dust, water, food, and soil and blood-lead level and should help in improving criteria for abatement procedures and standards for cleanup.

4. CURRENT ACTIVITIES REGARDING LEAD IN INDUSTRIAL APPLICATIONS

The Federal government, states, utilities, and others are supporting research or have just completed projects to address the critical problems associated with removing lead-containing paint from industrial structures. Several projects recently have been described in the literature. Examples of these include a study carried out by the North Carolina Department of Transportation on containment and beneficial reuse of blasting abrasive [26]. Two spans of a truss structure were blast cleaned and the debris was contained by state-of-the-art containment techniques. The contained spent abrasive was found to contain 4.2 percent paint debris and 0.5 percent lead by mass. The concentration of lead in the leachate obtained using EPA Method 1310 was 16.6 ppm. Although a negative pressure containment procedure was used, the abrasive collection rate was only 61 percent. Much of the loss of material was attributed to handling the material after containment rather than to the containment procedure. The spent blast debris was used in asphalt concrete; the asphalt concrete had acceptable strength and lead leaching characteristics.

The Pennsylvania Department of Transportation recently completed a project in which containment techniques and type of surface preparation were varied. One of the conclusions of the study was that the use of a recyclable abrasive with containment provides a cost-effective and environmentally acceptable way of conducting maintenance painting [27]. Pennsylvania now requires the use of recyclable abrasives for removal of paint from their bridges. Virginia also requires the use of recyclable abrasive for maintenance painting of bridges [28].

In addition to highway departments, other utilities have conducted pilot projects to help in maintaining structures having lead-containing paint. For example, studies carried out by Houston Lighting and Power over the past seven years have led to their current practice of requiring contractors to assume many responsibilities related to lead in paint. These include testing workers' blood for lead prior to starting a job, complying with

OSHA standard 29 CFR 1910.1025, monitoring airborne lead levels, and collecting wastes [29]. The increased cost associated with the presence of lead in paint included an estimated $\$200/m^3$ of spent abrasive to dispose of spent abrasive classified as a hazardous waste due to the presence of lead as compared with $\$4/m^3$ for spent abrasive classified as a non-hazardous waste. Other costs that may be increased by the presence of lead include those related to labor costs for building and moving containments, cleanup, and work environment.

In a current project, the Federal Highway Administration (FHWA) is investigating lead-containing paint removal, containment, and disposal [30]. The three-year study will include a review of waste disposal regulations, location and capacity of hazardous waste landfills, and cost for hazardous waste disposal. This review is to be submitted to FHWA in the fall of 1990. In addition to investigating recovery methods for recyclable abrasive and acceptable uses of maintenance debris, the study will evaluate methods of surface preparation to minimize the effect on the environment. Standards for classifications of containment efficiency will also be developed. The work will result in a design guide for maintenance painting of bridges.

There is a general recognition that standards for containment during removal are needed. The Steel Structures Painting Council is working to meet this need. Guides for lead-containing paint removal methods, containment methods, and waste disposal [31] are being prepared. Drafts of these guides have been developed and are being balloted. In addition, The Ontario Ministry of Transportation in cooperation with appropriate environmental groups, has developed requirements for containment based on surface preparation requirements, existing coating type, and location of structure [32].

5. ADDITIONAL RESEARCH AND STANDARDS NEEDS

The current emphasis on abatement and containment of lead-containing paint has led to increased research, development, and evaluation of new procedures for abating and containing lead-containing paint. Along with this increased activity, needs for additional knowledge, standards and procedures have been identified. For housing related problems, examples of these needs include: 1) performance criteria for materials used to encapsulate lead-based paint films, 2) improved criteria for acceptable clean-up levels of lead-containing debris, 3) cheaper methods for removal of lead-based paint, and 4) improved in-situ tests for lead in paint and dust. Promising techniques for paint removal and in-situ testing have been identified. However, additional study is required to evaluate these techniques and modify them, if necessary, to meet the needs for housing.
For industrial structures, innovative solutions and new ideas are being evaluated for removal, containment and disposal of lead-containing paint and debris. Industry, contractors and owners of structures are active in this area as evidenced by the increasing participation in annual meetings on lead paint removal sponsored by the Steel Structures Painting Council.

6. SUMMARY AND RECOMMENDATIONS

Problems associated with measuring lead concentration of existing paint films and removal of lead-containing paint have stimulated many research projects and related activities. The common goal of these projects is to help owners of structures having lead-containing paint comply with the relevant laws and regulations. Current research projects and other activities addressing both residential and industrial lead-containing paint problems were reviewed. For residential structures, the U.S. Department of Housing and Urban Development and the Environmental Protection Agency are leading a large effort to improve measurement of lead in paint and abatement of lead-based paint. For industrial structures, problems relating to removal of lead-containing paint, to containment of lead-containing paint debris, created as a result of removing old paint, and to disposal of the debris, when it is classified a hazardous waste, are topics of current research.

To help military installations maintain structures having lead-containing paint in a safe and cost-effective manner, the following actions are recommended:

- Maintain awareness of current research and engineering practices involving maintenance of lead-containing paint films. This will help avoid duplication of effort by the military and aid in timely incorporation of new knowledge in military guidance documents.

- Support research to investigate innovative, cost-effective procedures for removal of lead-based paint from residential structures. Abatement of lead-based paint from residential structures using currently available procedures is expensive and only limited work is being conducted to investigate new removal procedures.

- Support development of non-government (consensus) standards for lead paint containment and removal. Such standards would aid engineers in preparing painting contracts that involve lead-containing paint.

7. ACKNOWLEDGEMENTS

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In response to a recent regulation for abating lead-based paint in housing and other environmental regulations, research projects and other activities are being conducted to provide information on procedures for carrying out abatement and maintenance of lead-containing paint films in a safe and cost-effective manner. Relevant Federal regulations, and current research projects and other activities addressing these issues are reviewed.

12. KEY WORDS (6 TO 12 ENTRIES; ALPHABETICAL ORDER; CAPITALIZE ONLY PROPER NAMES; AND SEPARATE KEY WORDS BY SEMICOLONS)

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